Figure 6.21 – In-place filter test section

The in-place test sections should be designed, manufactured, and tested using the same criteria as the filter housing. The test housing will use apparatus and devices that are supplied as an integral part of the test section, including mixing devices and sample ports. The upstream and downstream test chambers will contain identical mixing devices to mix and disperse a uniform challenge air/aerosol ahead of the filter and the effluent from the filter being tested. Challenge aerosol inlet ports and upstream and downstream sample ports will be provided for each HEPA filter space and will be labeled for identification.

The manufacturer of these test sections will factory-proof-test its in-place test housings by performing an air aerosol mixing uniformity test using a test housing mock-up system. This test system will contain two filter banks in series, with each bank containing at least two filters in parallel. The proof test will include upstream sample and downstream efficiency readings. The factory-proof-test will verify that a leaking filter can escape detection in the conventional ten-duct diameter test, but can be "found" by the individual efficiency test. The manufacturer will have available a detailed report for the buyer as proof that the test housing has been qualified as described.

6.3 ENCLOSED FILTER INSTALLATION

Enclosed HEPA filters often appear to offer an ideal solution to some in-duct requirements. They are by design unitary; they do not require enclosures; and, after careful removal from the duct, they can be sealed and handled without personnel coming into contact with the contaminated filter core. However, they must be used with extreme caution. These designs are not intended to replace or serve as a containment housing. First, the wood-cased type, because the case is part of the system pressure boundary, does not meet the requirements of the National Fire Codes (specifically, NFPA 90A[2]) and should not be used in any application where the potential of a filter fire exists. Second, steel-cased enclosed filters can leak and should not be used in positive-pressure applications or where the filter case could be pressurized under system-upset conditions. This design is extremely difficult to produce as a total seal welded unit. They typically are not total seal welded or meet any welding requirements. The case is part of the system pressure boundary. Neither the wood-cased or wood-cased designs complete assembly pressure boundaries are leak tested by the "Pressure Decay Method" in accordance with the requirements of ASME N510-1995.[10] Although the filter core is adequately sealed into the case to prevent leakage between case and core under normal airflow, air can leak through the joints of the case, which are simply nailed, bolted, or riveted through a layer of compressed glass-fiber matting. This seal is not airtight and under positive pressure is not an effective particle filter. For this reason, when steel-cased enclosed filters are to be used in systems in which there are or could be significant levels of contamination, it is recommended that the filters be bagged at all times.

Enclosed filters are most commonly furnished with plain nipple ends and are generally sealed into the duct by means of (1) flexible tubing and clamp rings, (2) specially designed elastomer sealing glands or cuffs, or (3) a wrap of duct tape. The third method is not reliable and, if used, the taped connection should be protected with a metal collar. All of these seals are subject to failure when exposed to fire or hot air and cannot be recommended for applications where high levels of radioactivity may be present. Flanged joints are

the only type that can withstand extended exposure (more than 10 min) to high-temperature air or to fire inside or outside the duct.

Individual filter supports are recommended. The use of temporary supports on upper filters is sometimes necessary to permit replacement of one of the lower filters. As with open-face filters, horizontal airflow through enclosed filters is recommended.

The enclosed HEPA Filter design is not intended or recommended to replace or serve as a containment housing. When disconnecting the enclosed filter from the ductwork, extreme caution and care must be taken to minimize the contamination leakage that can occur before the filter is suitably bagged and sealed for handling.

6.4 CYLINDRICAL FILTER ELEMENTS

The cylindrical HEPA filter is another configuration that often appears to offer ideal solutions to certain installation requirements. However, this type of filter must be used with caution because of shortcomings in its construction. One manufacturer makes a spiral of the filter material and a separator; the others make a conventional pleated-medium-and-separator core that is trimmed to a cylindrical shape. In both designs, the core is slipped into a molded or welded-seam cylinder and sealed by catalyst-activated plastic foam or an adhesive as shown in **FIGURE 6.22**. There is no interference or pressure fit between core and casing, as in the open-face and enclosed rectangular configurations, because the core would be damaged when fitted into the case. In addition, because the cases are often made from light-gage, easily deformed sheet metal, they are often considerably "out-of-round." The result is often a filter element that leaves much to be desired in the areas of leak integrity after a period of service and resistance to the exigencies of air cleaning system service.

Cylindrical HEPA filters can be obtained with or without flanges on one or both ends. The filters without flanges are used in push-through (so-called incessant) installations as shown in **FIGURE 6.23**. The filters are sealed into a cylindrical opening with one or more half-round

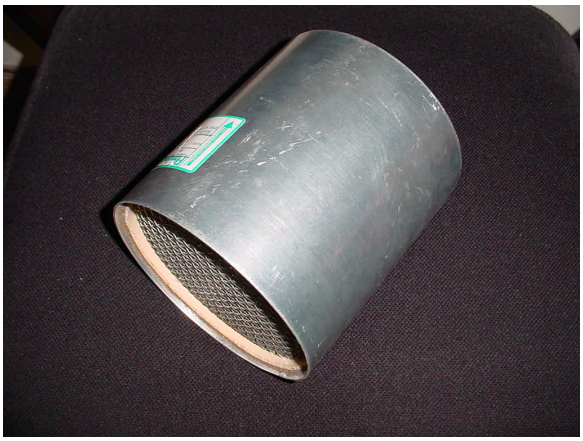

Figure 6.22 – Welded seam cylinder

circumferential gaskets (fixed to the filter), which make a slight interference fit with the receiver. As the filters are often out-of-round and a reliable interference fit between filter and receiver is impracticable, push-through installations are often unreliable under system-upset conditions. Push-through filters are subject to being blown out of the receiver if pressure differentials become high. Flanged cylindrical HEPA filters as shown in **FIGURE 6.24** can be installed in pipe openings by bolting them to a flange on the pipe or by clamping the filter flange between mating pipe flanges. Conventional neoprene sponge gaskets are used for sealing (see Section 4.4.6). Because filter flanges and cases are characteristically made from light-gage sheet metal with the flange seal-welded to the cylinder, these filters often leak at the flange-to-case weld. The flange also often becomes deformed. Either condition results in an installation that is difficult to seal.

Figure 6.23 – Cylindrical HEPA filter